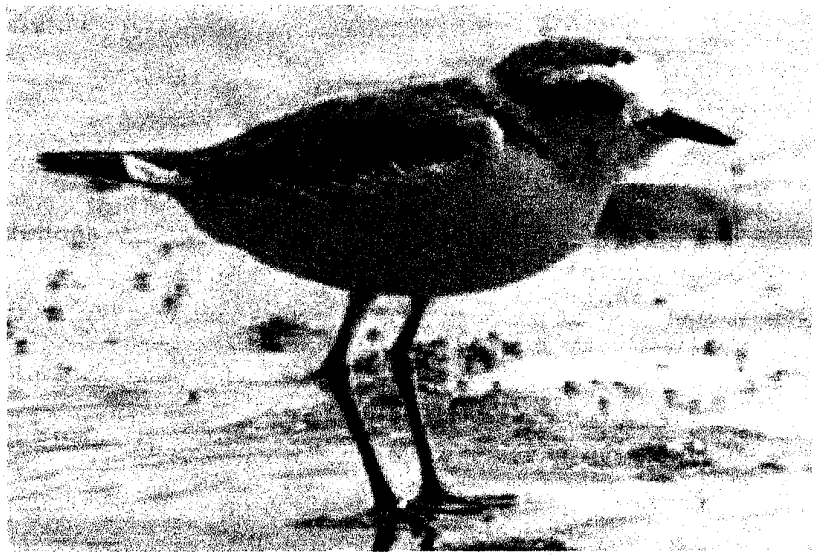
Moss Landing Salt Ponds
Habitat Enhancement Plan



June 18, 2001

Prepared for:
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LEADER IN WETLANDS CONSERVATION

Introduction

Moss Landing Wildlife Area comprises 872 acres of tidally influenced habitat in northern Monterey County. The Wildlife Area is located near the mouth of Elkhorn Slough at Moss Landing, CA. The Moss Landing salt ponds are a uniquely valuable component of this habitat, consisting of 153 acres of retired salt evaporation ponds. Highway 1 borders the ponds to the west, Elkhorn Slough to the south, Elkhorn Ranch (uplands) to the east and Bennett Slough to the north. Both Bennett and Elkhorn Sloughs are connected to Monterey Bay, the former by a culvert under Highway 1 and the latter by the Highway 1 Bridge.

The Department of Fish & Game (CDFG) purchased the ponds from Western Salt in 1984 for the purpose of maintaining shorebird and waterfowl habitat in the area. Prior to the purchase, the ponds had been inactive for a period of years, leading to a levee breach in 1982. The Point Reyes Bird Observatory (PRBO) assists CDFG by providing water management for the ponds.

The salt ponds are extremely important to the Monterey Bay breeding population of Snowy Plover. In 1999, 63% of the Snowy Plover young known to have fledged in the Monterey Bay region were produced in the salt ponds. The ponds have the highest hatching success (86% in 1999) and fledging success (1.91 chicks/male in 1999) in Monterey Bay. The ponds are the most productive Snowy Plover habitat in the Monterey Bay region.

Brown pelicans frequent the ponds and they have been observed roosting in the ponds, usually in shallow water (Doug George, PRBO, personal communication). In addition to these endangered species, the ponds provide various habitat functions for numerous shorebirds, seabirds and waterfowl. American avocets and black-necked stilts both nest on the levees and rear their young in the ponds.

Existing Conditions

The ponds were originally designed to operate in series. While this was suitable for commercial salt production, it poses difficulties in managing water for wildlife habitat. Water that is introduced into one pond must be raised higher than desired in order to push it into the next pond in line, and so on down the chain. This makes managing each pond at an optimal level for habitat production an impossible task. In addition, not having an independent source of water for each pond reduces water circulation and can result in poorer water quality in the ponds further down the chain.

CDFG constructed an exterior levee from dredge spoils in 1989, and half of the ponds were allowed to return to salt marsh. In the remaining salt ponds, CDFG installed new water control structures in 1991. Water is still brought in through an intake off Elkhorn Slough under the current system. This intake feeds a 2.7acre ditch that dissects Ponds B and D (Figure 1). Water from the intake ditch can be introduced directly into Ponds A, B,

C and D. There is no outlet for the ponds, however, and water that does not evaporate must exit the same water control structure that it entered. This limits circulation and can lead to stagnant water in the ponds.

The upper end of Pond C and Ponds E through I seldom, if ever, receive water under the current system. As a result they are being encroached upon by pickleweed. It is possible to push water back to the upper reaches of Pond C and into Pond F, but this would be done at the expense of habitat in the lower reaches of Pond C and Pond D, respectively. Even then it is unlikely that the water could be maintained at a level that would prevent pickleweed encroachment.

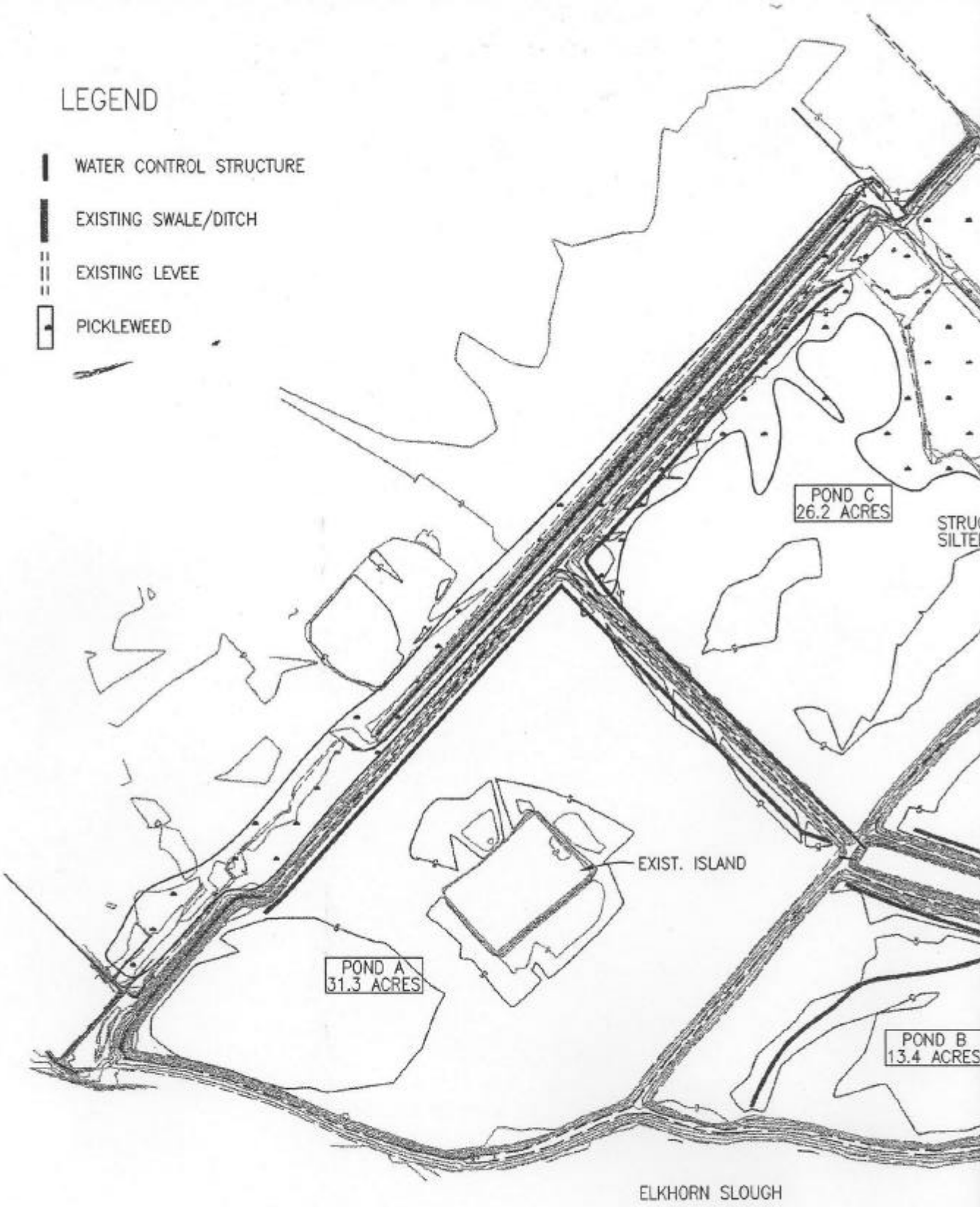
The pickleweed poses a problem in that it reduces the amount of mud flats available to the shorebirds and provides cover for predators. It also reduces the value of the substrate as nesting habitat for the Snowy Plover. A report written by PRBO staff indicates that the ability to independently flood up ponds for long durations in order to control the vegetation would be desirable (George 1997). This is impossible given the current pond configuration.

With the existing ground configuration, the water in the ponds is primarily located in the borrow ditches adjacent to the levees. This attracts shorebirds to these areas for foraging, closer to the vegetated levees and the terrestrial predators that use them. The levees also support annual grasses, which provide habitat for small mammals. The mammals attract raptors to the pond system; the raptors prey on both the mammals and Plover chicks.

Purpose

The management goal for the Moss Landing salt ponds is to provide foraging and breeding habitat for the Snowy Plover and other shorebirds, as well as roosting areas for brown pelicans and migratory waterfowl.

The goal of this proposal is to reconfigure the existing system so that the management goal can be met in a robust manner: one that would provide reliable habitat with a minimal amount of water manipulation and personnel commitment. The Moss Landing salt ponds are remotely located, with no staff on-site. Thus, it is crucial that the system be designed to function with minimal management.


LEGEND
WATER CONTROL STRUCTURE
EXISTING SWALE/DITCH
EXISTING LEVEE
PICKLEWEED
POND C
26.2 ACRES
EXIST. ISLAND
POND A
31.3 ACRES
POND B
13.4 ACRES
ELKHORN SLOUGH

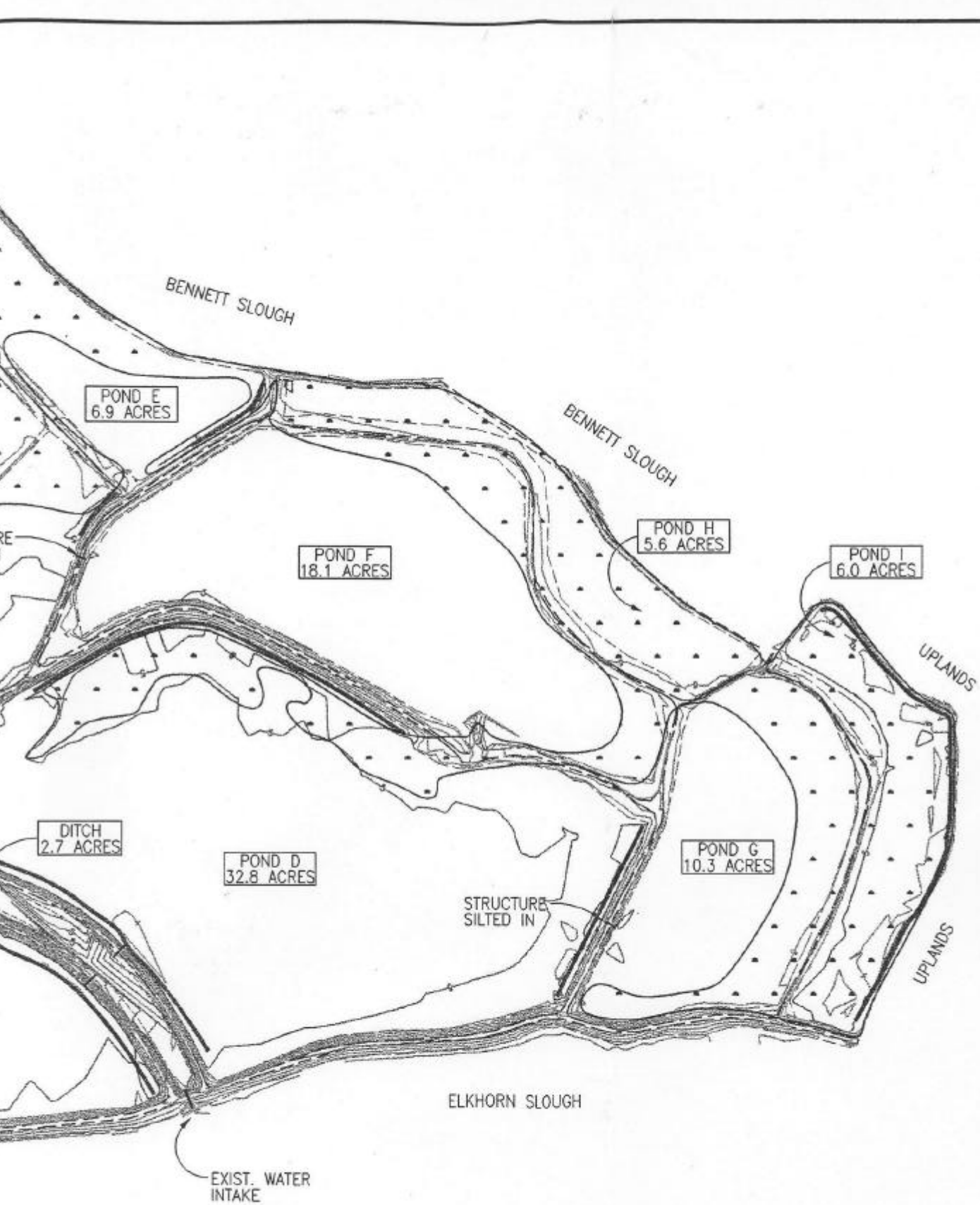


FIGURE 1

DUCKS UNLIMITED INC. WESTERN REGIONAL OFFICE	PROJECT NO. DU-CA-272-1	DESIGNED BY:
	MOSS LANDING SALT PONDS EXISTING CONDITIONS	DRAWN BY: DU
		SURVEYED BY: DU
		CHECKED BY:
DATE: 2/10/01	SHEET NO. 1 OF 1	APPROVED BY: / APPROVED BY:

Design Challenges

The only source of water currently available to the salt ponds is a gravity fed tidal inlet off Elkhorn Slough. The average pond elevation is just over 5.0 feet North American Vertical Datum 1988 (NAVD88). Table 1 shows the correlation of tidal datum for Elkhorn Slough at Highway 1 bridge and NAVD88. The two datums are very closely correlated in this area. As Table 1 shows the mean higher high water (MHHW) is approximately the same elevation as the pond bottoms. Therefore, it is crucial that the intake structures be designed with sufficient capacity in order to capture the volume of water required for management during the high end of the tide cycle.

Table 1
Tide Elevations in Feet for Elkhorn Slough
Highway 1 Bridge, Moss Landing

Tide Stage	Tidal Datum*	NAVD88
MHHW	5.33	5.28
MHW	4.64	4.59
MTL	2.86	2.81
MLW	1.08	1.03
MLLW	0.00	-0.05

Notes:
1. NOS published data, publication date 5/19/1982
2. Tidal datum are based on the following:
   Length of Series = 4 months
   Time Period = June-July 1976, May-June 1977
   Tidal Epoch= 1960-1978
   Control Tide Station= Monterey (941 3450)

The installation of a pumping station is another possibility for providing adequate water supply to the system. This would allow water intake over a greater range of tides. Power lines border the project site and could be used to bring power to a pumping station. However, this would entail a greater capital expense and require reoccurring maintenance and power expenses. In addition, pumping stations are attractive nuisances and could potentially experience vandalism. Finally, pumping facilities require that personnel be on site to operate them. However, this investment is somewhat offset in that the manager would not have to wait until a higher tide to flood the ponds.

Vegetation is encroaching on the northern ponds in the system. Some of these ponds have been completely overtaken by pickleweed and provide zero Snowy Plover nesting habitat. The system must be designed in a manner that will allow independent flooding and holding of water for each pond in order to provide vegetation control without affecting the operation of the other ponds in the system.

Increased water levels will result in increased erosion of perimeter levees especially since high velocity winds are frequent in the area. PRBO has suggested that the pond levees be free of vegetation in order to eliminate predator habitat (vegetation provides habitat for

small mammals that attract raptors and terrestrial predators into the salt ponds). Vegetation is commonly used to resist wave erosion and the elimination of the vegetation will obviously predispose the levees to a higher rate of erosion.

High winds and fine material have resulted in the silting-in of westerly exposed water control structures (Figure 1). This obviously poses a problem to water management. The new system would have to be designed in a way that would reduce the tendency for silting-in of the water control structures.

PRBO manages the ponds for breeding shorebirds by trickling in small volumes of slough water to maintain low water levels and brine invertebrate populations. Water is transported and held in old borrow ditches, leaving most of the pond bottom dry in order to provide nest substrate for the Snowy Plovers. The borrow ditches provide foraging opportunities for the breeding pairs and their young. These ditches are adjacent to the levees, which brings the foraging birds closer to the levees, where they may be more susceptible to terrestrial predators. On the other hand, the absence of swales in the center of the ponds allows the chicks greater avenues of escape from avian predators (Doug George, PRBO, personal communication).

Recommendations

Ducks Unlimited Inc. (DU) has performed a preliminary design study for the Moss Landing salt ponds. The study considered many factors including but not limited to the issues presented above. Appendix A shows a preliminary design for the habitat improvements recommended under this proposal.

The primary need for the system is independent water control for each pond. Therefore, independent intake and drainage structures must be provided for each pond. As previously mentioned, both Elkhorn and Bennett Sloughs border the ponds. Bennett Slough is drastically muted by the culvert connecting it to Monterey Bay, and as such has lower high tide elevations than Elkhorn Slough. This can be capitalized upon by utilizing Bennett Slough as the drainage recipient for the system. The ponds would be able to drain into Bennett Slough even during high tides. Therefore it is logical to rearrange the ponds to allow water intake from Elkhorn Slough and water drainage into Bennett Slough.

Since Elkhorn Slough was identified as the water source for the ponds, the first step was to provide independent water supply to each pond from Elkhorn Slough. As previously mentioned the existing pond inverts are roughly at MHHW. Therefore it is essential that storage capacity be provided such that water volume captured during high tides is sufficient to meet the system's needs. The 2.7-acre intake ditch is currently the only reservoir for holding the high tide waters. The new configuration combines the intake ditch and Pond B to increase the storage capacity for the entire pond system. In this manner the capacity of the system is increased without altering the existing intake configuration in Elkhorn Slough. The new Pond 6 would be approximately 16 acres in size. The levee separating Pond B and the intake ditch would be breached at both ends,

limiting the amount of excavation required to accomplish the desired task and at the same time providing a nesting/roosting island.

Currently Ponds A through D are the only ones that have direct access to a water supply. Under this plan, Ponds C through H would be reconfigured in order to gain better water management capabilities (see Appendix A). This would result in the creation of Ponds 2, 3 and 4, each with an independent intake from Pond 6 and drainage into Bennett Slough. This configuration would allow the ponds to be placed on a rotational management system where any of the ponds could be managed for either shorebird habitat or flooded for pickleweed control without affecting the adjacent ponds. In addition, by reducing the number of ponds in the system the amount of levee is reduced. This is desirable because it simultaneously reduces the amount of upland habitat available to small mammals, and the number of corridors available to terrestrial predators.

Not only does the reconfiguration allow for better water control, but it also eliminates the siltation problems experienced with the current pond configuration. The existing structures connecting Pond C with Pond F and Pond D with Pond G (Figure 1) both have a western exposure and have silted-in due to the wind-generated waves. The new configuration would reduce the amount of fetch in the existing Ponds D and F by dissecting them with a levee and creating Ponds 3 and 4. The westerly exposed water control structures would be eliminated. All drainage structures face south, and are located in the northern edge of the ponds. This would limit the amount of siltation that the drainage structures experience since the primary sediment transport is in an easterly direction. The intake structures will be able to keep themselves clear through normal operation.

The intake structures will consist of combination gates. These gates allow the operator to bring water in on successive high tides and hold it during low tides without further manipulation. In this manner the water level can be ratcheted up over successive tide cycles to the desired elevation. The structures can be operated in reverse in order to drain the system into Elkhorn Slough on low tides, if so desired.

In addressing the issues of exposure to predators and foraging areas, DU suggests using small gravity fed water lines to deliver water to shallow ponds in the center of Ponds 2, 3 and 4. Water can be trickled in from the Pond 6 reservoir to maintain water levels and brine populations without restricting the movement of chicks. This also would increase the fringe area available to the shorebirds for foraging.

The drainage structures on Bennett Slough would provide better water management control by allowing the ponds to be maintained at the desired water depth while flushing slough water through the system. This would be accomplished through the use of flashboard risers, which can be set to spill excess water and maintain a desired elevation. Since the structures drain into Bennett Slough, the excess water can be spilled regardless of the tide cycle. This will maintain the desired water depth without the presence of an operator, eliminating the risk of overfilling the ponds. In addition, water will be passed through the system with each high tide cycle, greatly improving circulation. This will

improve the quality of habitat for wintering waterfowl and also give the operator the ability to keep pickeweed stands inundated.

Pond 5 is covered in pickleweed and is adjacent to neighboring uplands and trees. It's potential to provide shorebird habitat is negligible. Therefore, this pond will be managed as muted tidal wetlands by placing structures on Elkhorn Slough and Bennett Slough. This would allow the management of this pond for waterfowl habitat and hopefully provide a buffer between predators and the shorebird ponds.

The higher water levels in the ponds being managed for pickleweed control results in a higher potential for levee erosion. This can be protected against in several ways, including soil-cement treatment, rip rap, flattened and/or vegetated slopes and sacrificial berms. Rip rap obviously isn't desirable in this situation; neither are vegetated slopes due to the predator corridors they could create. Soil cement treatment would prevent erosion and initially prevent vegetation growth. Over time, however, any cracks that formed would allow the establishment of vegetation. It is also unknown how the soil cement would affect any potential habitat value of the levees themselves. It was decided that the windward levee slopes would be flattened to protect against erosion.

Finally, the buffer between Pond A (Pond 1) and Elkhorn Slough has been steadily eroding for some time. The integrity of this levee is essential to the protection of the salt pond system. This project would rebuild the slope utilizing on-site material and place slope protection rock to prevent any future erosion.

Overall this design will provide a high range of habitat diversity that can be manipulated with a minimal amount of personnel time. Each pond can be managed as a dry playa interspersed with brackish water ponds and swales (for breeding shorebirds), as a fully flooded pond (for pickleweed control), or as a muted tidal system (for wintering waterfowl and seabirds). Snowy plover breeding habitat will be immediately enhanced as well as protected in the long term.

Cost Estimate

This proposal is based on a preliminary design study performed by Ducks Unlimited. The study was funded by DU's MARSH (Matching Aid to Restore State's Habitat) program. In order to finalize the design, further hydrological, biological and engineering investigations need to be made in order to insure a design that would perform as indicated herein. It is estimated that a finalized design would cost approximately $30,000. The construction estimate for the preliminary design in this proposal is $750,000. This is assuming no major changes have to be made to the final design. A line item cost estimate for this proposal is provided in Appendix B.

Project Authorities

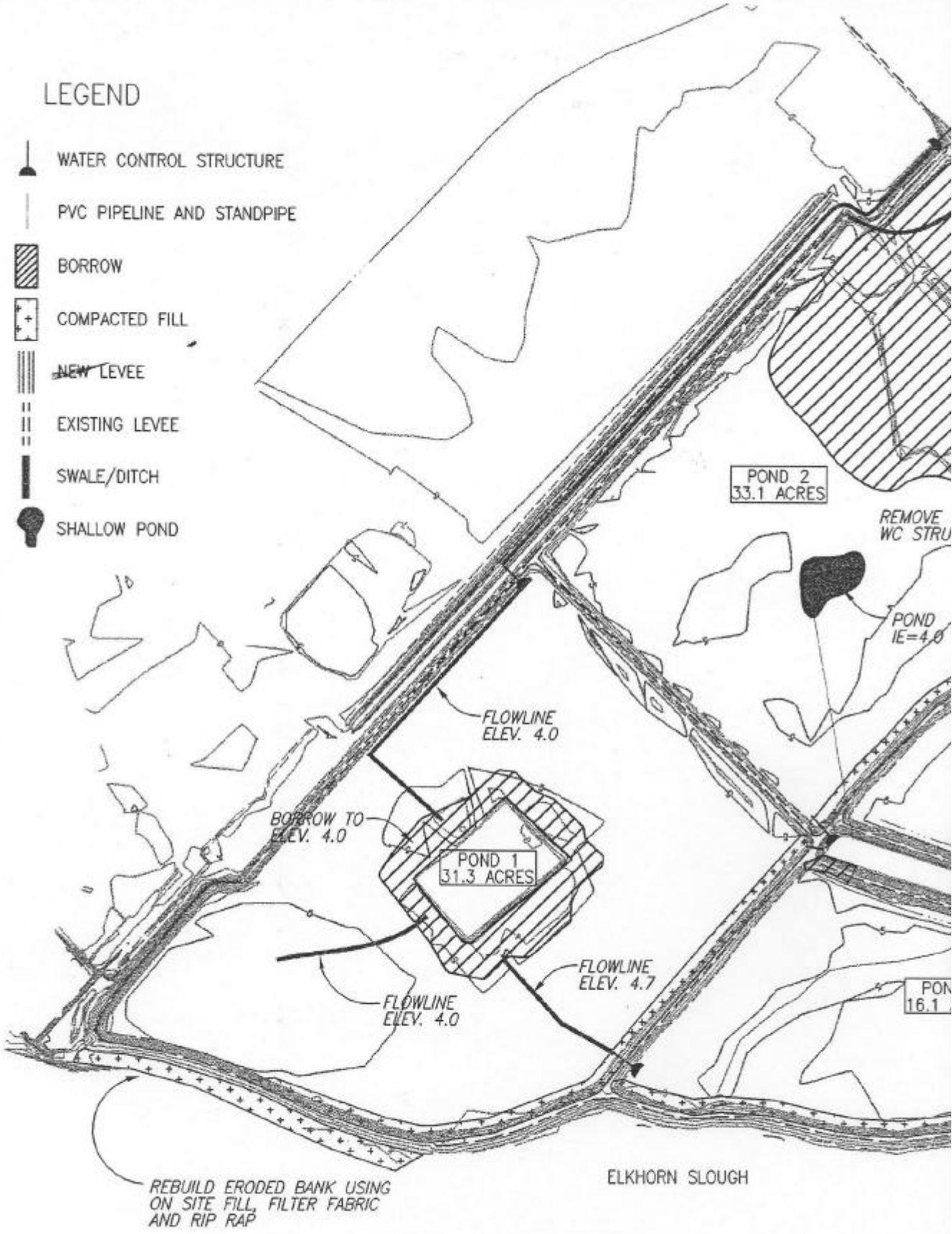
DU proposes to provide biological and engineering services to finalize the project design and provide construction management for this project. To complete this project we must

establish a cooperative agreement with the CDFG and secure funding sources for the activities mentioned herein. This cooperative agreement shall give DU authority to begin work on the project and allow access to the Moss Landing salt ponds for final survey and construction activities.

Literature Cited

George, D. 1997. Recommended actions to maintain and enhance wildlife values at the Moss Landing salt ponds. Unpublished report to California Department of Fish and Game, Region 3. 3 pages.

Page, G.W., Warriner, J.C., Warriner, J.S., Goerge, D., Neuman, K., Eyster, C., Dixon, D., Henkel, L., and Stenzel, L.E. 1999. Nesting of Snowy Plovers at Monterey Bay and Pocket Beaches of Northern Santa Cruz County, California in 1999. Point Reyes Bird Observatory, Stinson Beach. 15 pages.

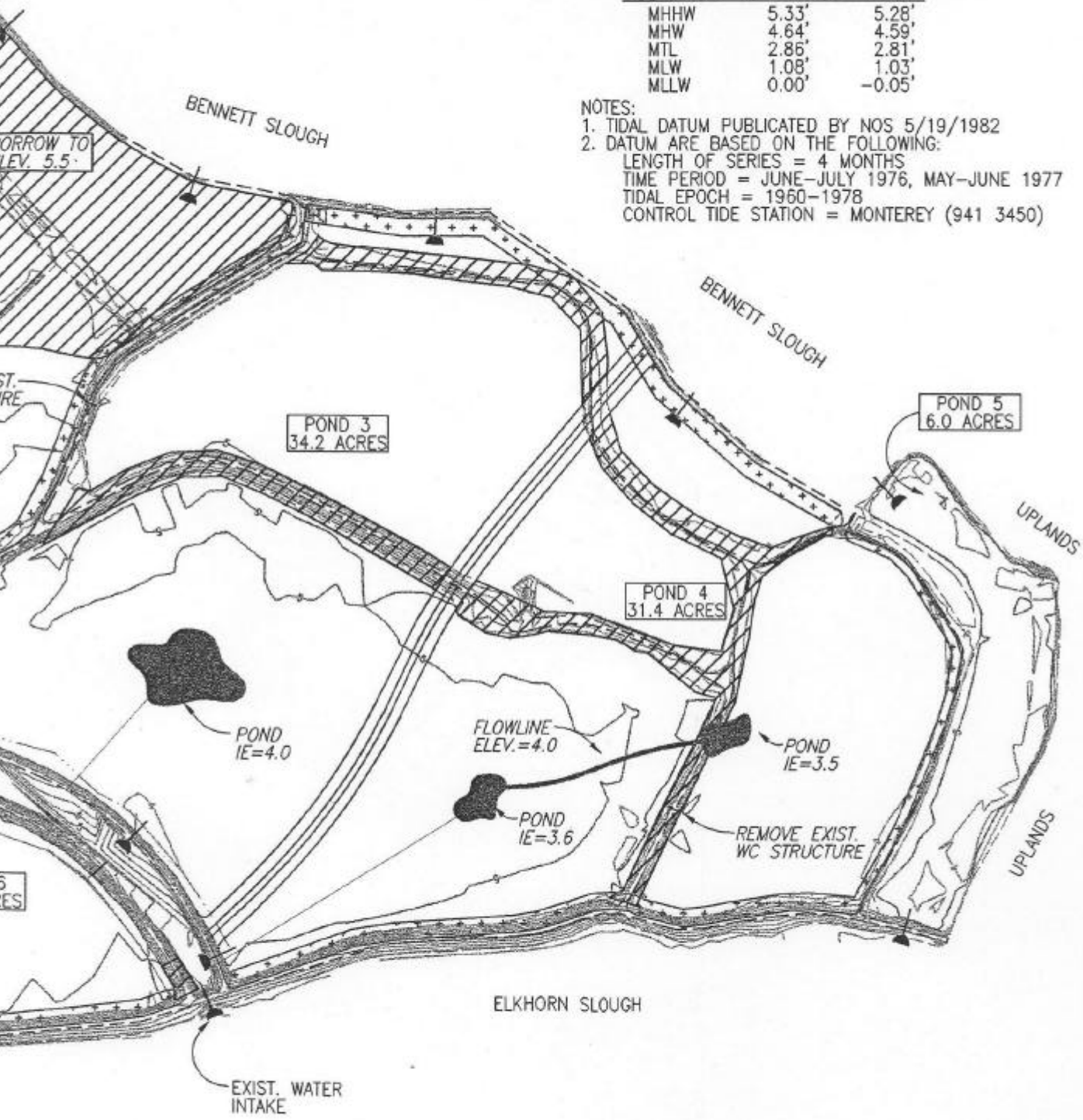


Appendix A

TIDAL DATUMS AT ELKHORN SLOUGH
HIGHWAY 1 BRIDGE, MOSS LANDING

TIDE LEVEL	TIDAL DATUM	NAVD88
MHHW	5.33'	5.28'
MHW	4.64'	4.59'
MTL	2.86'	2.81'
MLW	1.08'	1.03'
MLLW	0.00'	-0.05'

NOTES:
1. TIDAL DATUM PUBLICATED BY NOS 5/19/1982
2. DATUM ARE BASED ON THE FOLLOWING:
   LENGTH OF SERIES = 4 MONTHS
   TIME PERIOD = JUNE-JULY 1976, MAY-JUNE 1977
   TIDAL EPOCH = 1960-1978
   CONTROL TIDE STATION = MONTEREY (941 3450)



PRELIMINARY

REVISIONS			
REV. NO.	DESCRIPTION	DATE	APPROVED
1			
2			
3			
4			
5			

DUCKS UNLIMITED INC.
WESTERN REGIONAL OFFICE

PROJECT NO. US-CA-272-1

MOSS LANDING SALT PONDS HABITAT ENHANCEMENT

DESIGNED BY: SC
DRAWN BY: SU
SURVEYED BY: SU
CHECKED BY:

DATE: 2/13/01
SHEET NO. 1 OF 1
APPROVED BY:
APPROVED BY:

Appendix B

Cost Estimate for Habitat Enhancement at the Moss Landing Salt Ponds

DU Project Number: US-CA-272-1
DU Project Name: Moss Landing
Created May 16. 2001

Phase I - Planning & Design

Line Item	Unit	Unit Price	Quantity	Extended	Total
Purchase WL recorder	EA	$2,500.00	2	$5,000	$5,000
Design Engineer					$10,720
Install WL recorders	HR	$67.00	24	$1,608	
Collect WL recorders	HR	$67.00	16	$1,072	
Evaluate Data	HR	$67.00	16	$1,072	
Adjust & finalize design	HR	$67.00	64	$4,288	
meetings(coop. & reg. agencies)	HR	$67.00	40	$2,680	
AutoCAD	HR	$55.00	32	$1,760	$1,760
Biologist					$4,288
Design input	HR	$67.00	32	$2,144	
meetings w/ cooperator	HR	$67.00	32	$2,144	
Travel & Meals	DY	$150.00	13	$1,950	$1,950
Sub Total					$23,718
Contingency	10%				$2,372
Sub Total					$26,090
Indirect Overhead	16.25%				$4,240
Phase I Total					**$30,329**

Phase II - Construction

Line Item	Unit	Unit Price	Quantity	Extended	Total
Construction staking					$2,950
Surveyor	HR	$55.00	40	$2,200	
Travel & Meals	DY	$150.00	5	$750	
Construction					$477,087
Mobilization	LS	$43,371.50	1	$43,372	
Compacted Fill (In dry)	CY	$3.50	15500	$54,250	
Excavation	CY	$2.00	20500	$41,000	
Ditch cleaning	LF	$2.50	1530	$3,825	
Compacted Fill (Elkhorn Sl. Slope	CY	$10.00	5000	$50,000	
Rip Rap	CY	$70.00	1000	$70,000	
Canal Gate	EA	$5,000.00	4	$20,000	
Combination gate	EA	$8,000.00	6	$48,000	
Flashboard riser	EA	$2,000.00	5	$10,000	
Flap Gate	EA	$2,000.00	9	$18,000	
Culvert pipe	LF	$35.00	600	$21,000	
Install Water Control Structures	EA	$7,000.00	13	$91,000	
4" PVC pipe, risers and valves	LF	$4.00	1660	$6,640	
Sub Total					$480,037
Construction Inspection	10%				$48,004
Project Management	10%				$48,004
Contingency	15%				$72,005
Sub Total					$648,049
Indirect Overhead	16.25%				$105,308
Phase II Total					**$753,357**